Update on Transmission Planning for Wind Power in the Upper Midwest

The Road to Market

State Summit

Wind Powering America

Pittsburgh, PA

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Key Issues – Transmission Planning & Wind

Wind plants are:

- **Site dependent** – best wind resource often remote from load
- **Developed quickly** – much quicker than transmission
- **Relatively small** – aggregation helps effective transmission solutions
- **Variable** – doesn't need transmission for full capacity all the time
- **New** – not as familiar to transmission planners and operators

- Transmission for energy, capacity, or both?
- Who develops new transmission? When? Who pays?
- Who gets to use the capacity on the new lines?

Key Issues – Transmission Planning & Wind

- Delivery of wind energy to market requires:
  - **Use more of the grid**
  - **Build more of the grid to use**
- Regional studies of new transmission capacity
  - aggregate and integrate new wind plant developments in a forward looking time frame

Solutions – Transmission Planning & Wind

- **Using Existing Transmission Better**
  - **Conditional Firm** – tap unused transmission capacity
  - **Dispersed Generation** – near load / available transmission
- **Building More Grid Capacity**
  - **Aggregated** – transmission solutions for large amount of wind power rather than one wind plant at a time
  - **Integrated** – planning for wind power along with other power system needs
  - **Forward looking** – planning infrastructure for large amounts of wind power today
- **Optimizing Power System Operations**
  - **Balancing Authority Consolidation**
  - **Wind Integration**

Midwest Wind Power

	Wind Power, MW				
	Existing[1]	2006 - 2012 Projected New[2]	Total Potential[3]	% of State Consumption in 2010[4] 5%	10%
Illinois	107	2,500	6,980	2,668	5,336
Iowa	836	1,000	62,900	827	1,654
Minnesota	744	2,000	75,000	1,250	2,499
Nebraska	73	500	99,100	559	1,118
North Dakota	98	750	138,400	220	440
South Dakota	44	1,500	117,200	187	374
Wisconsin	53	1,250	6,440	1,363	2,726
Total	1,955	9,500	506,020	7,073	14,147

Notes:

1. Nameplate MW, American Wind Energy Association, May 2006, http://www.awea.org/
2. Survey of active wind developers, community projects, announced projects, & portion of interconnection queues
3. Avg MW (approx. 1/3 of nameplate capacity), *An Assessment of Windy Land Area and Wind Energy Potential*, Pacific Northwest Lab,1991
4. Wind power nameplate capacity; 35% net annual capacity factor and % consumption based on energy and growth from Energy Information Administration, 2001, http://www.eia.doe.gov/cneaf/electricity/st_profiles/profiles.pdf

Current & Recent Midwest Planning Activities

- **Using Existing Transmission Better**
  - Dakotas Wind Transmission Study
  - Community-Based Energy Development Study
- **Building More Grid Capacity**
  - Midwest Wind Development Plan
  - MISO Transmission Expansion Plan 2006
  - Buffalo Ridge Generation Outlet
  - CapX 2020 / SW MN to Twin Cities 345 kV
- **Optimizing Power System Operations**
  - MISO Ancillary Services Markets
  - Minnesota Wind Integration Study

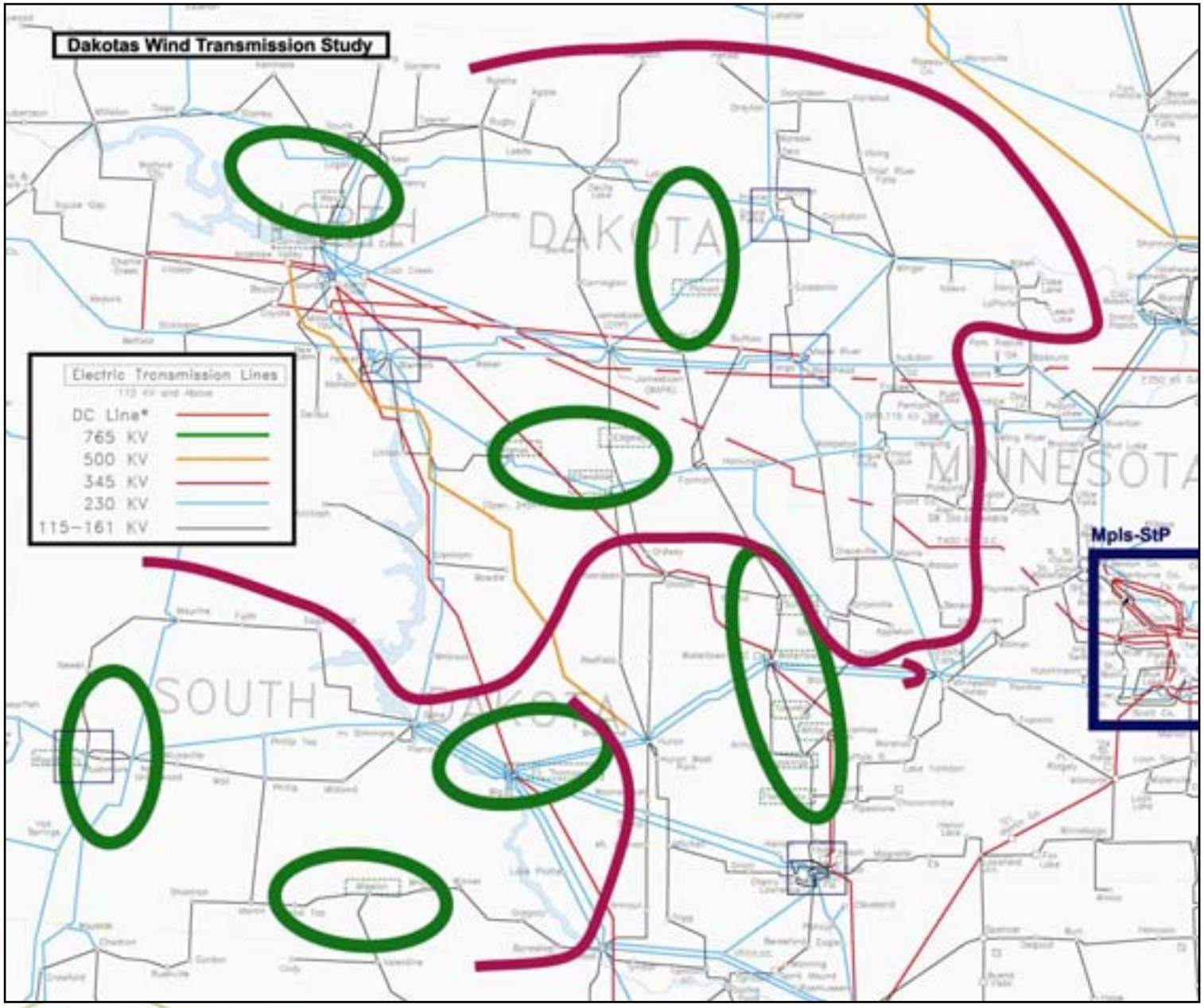
Using the Existing Transmission System Better

Dakotas Wind Transmission Study – WAPA

- Placement of 500 MW of new wind power in North and South Dakota and associated transmission

Study Scope:

- **Analyze Non-Firm Transmission Potential**
- Assess Potential of Transmission Technologies
- Study Interconnection
- Study the Delivery to Market

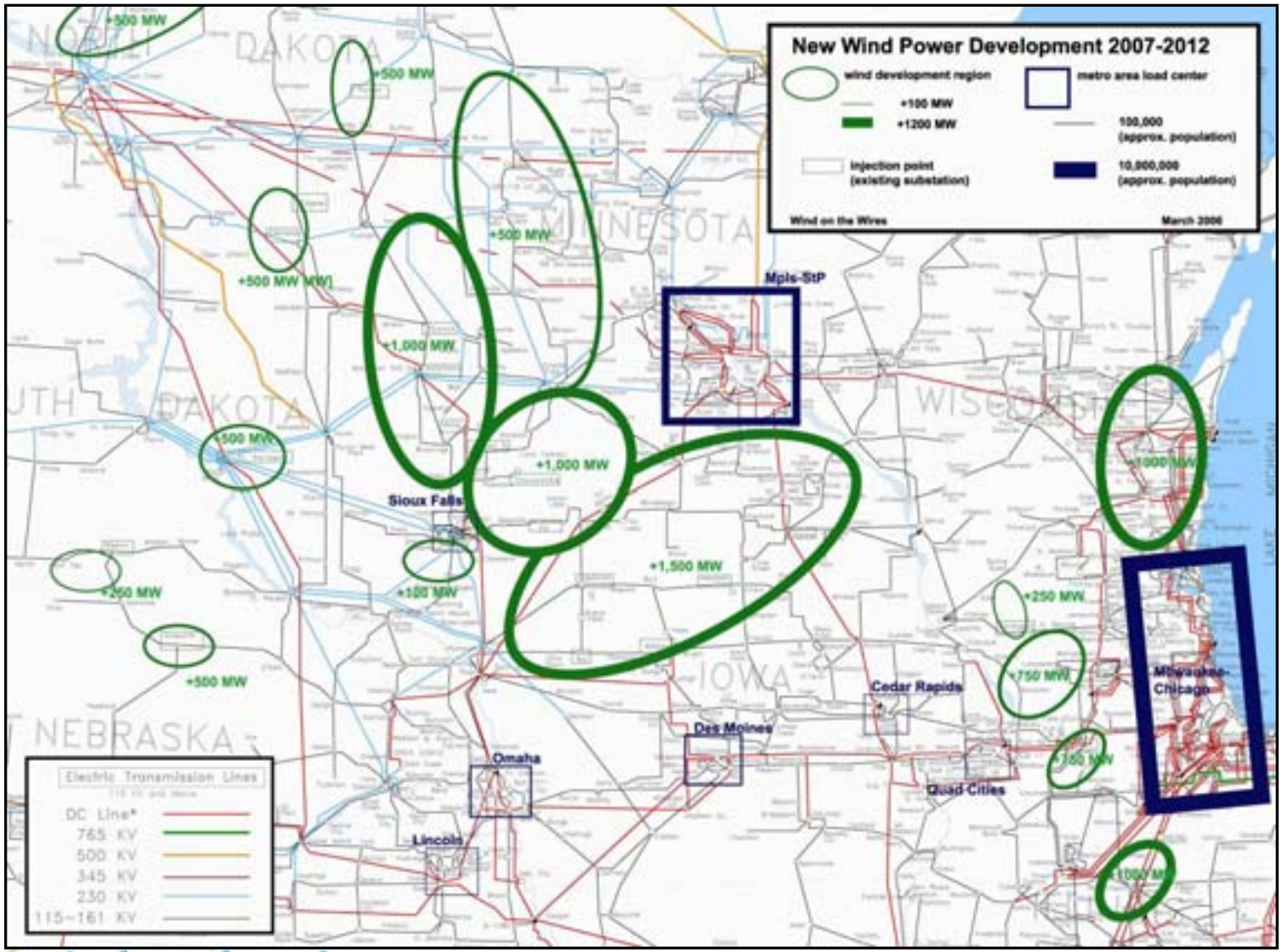

Dakotas Wind Transmission Study
Electric Transmission Lines
DC Line*
765 KV
500 KV
345 KV
230 KV
115–161 KV
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
Mpls-StP

Key Results for WAPA DWTS:

- **Analyze Non-Firm Transmission Potential**
  - **under normal, system intact conditions, non-firm transmission is available 99.5% of the time across the three interfaces for up to 500 MW at any 1 of the 7 wind sites studied**
- Study Interconnection & Delivery to Market
  - steady-state contingency and regional stability analysis identified limitations in the existing system
- Assess Potential of Transmission Technologies
  - steady state overloading can be mitigated with dynamic ratings & reconductoring; dynamic stability & low voltages can be improved with series capacitors, SVCs, STATCOMs

Building More Grid Capacity

Regional Planning for Aggregate Wind Power



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MISO Transmission Expansion Planning (MTEP)

MTEP-03

- Included **10,000 MW** High Wind Scenario based upon a Midwest Wind Development Plan (WOW/AWEA)

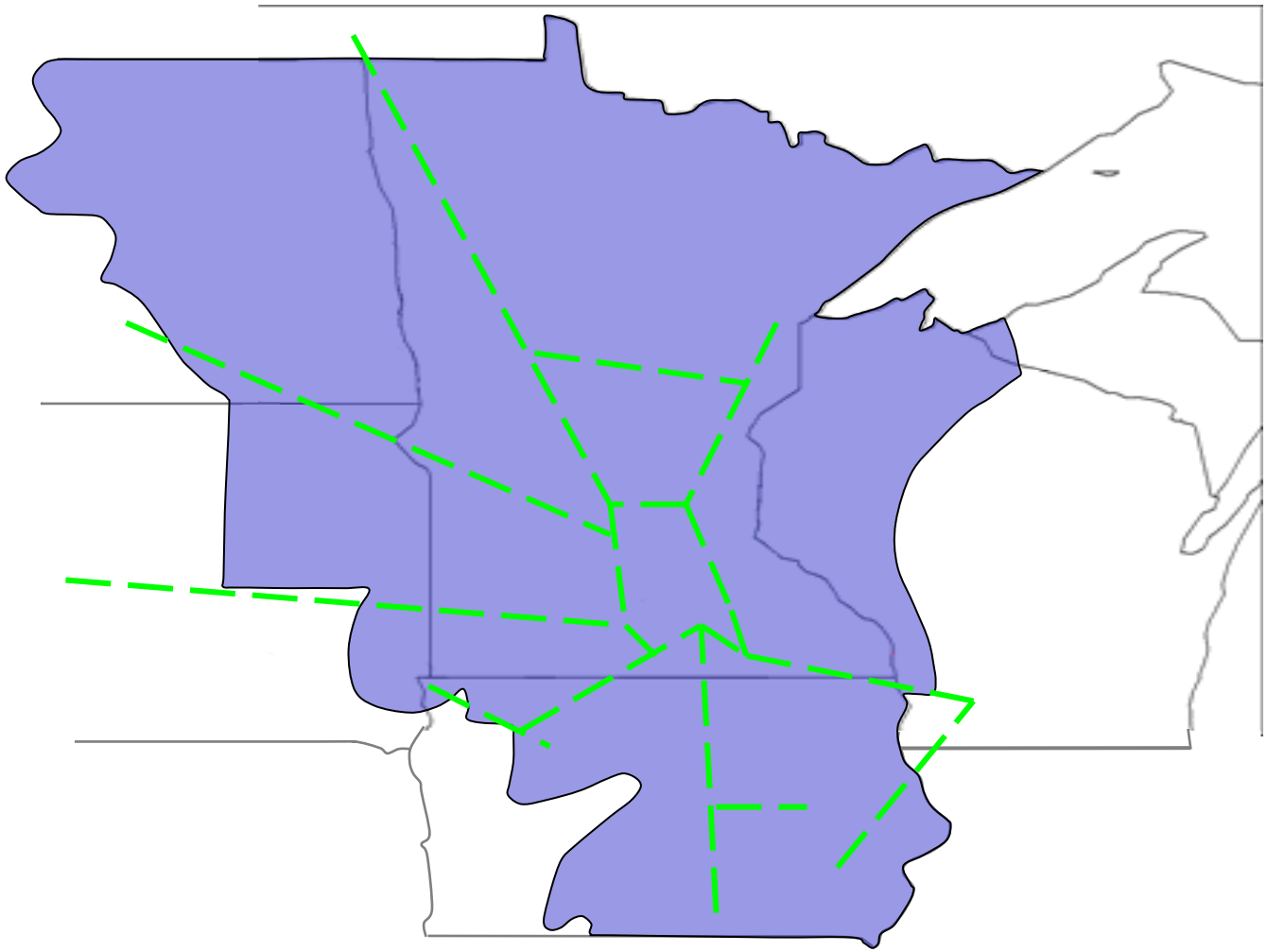
MTEP-05

- Further developed two major sets of lines for delivery of wind, identified in MTEP-03, as Exploratory Studies (Northwest and Minnesota / Iowa)

MTEP-06

- Builds on MTEP-05 lines and includes 10% wind energy in the MISO footprint (**15 – 20,000 MW** of wind) as part of identification of regionally beneficial projects

CapX 2020 -- Transmission Concept Plan



CapX 2020 Project Groups – established by timing and priority of needs

Project Group	Expected CON Filing	Expected In-Service
Group I – CON to be filed within one year		
Big Stone II Transmission	3rd qtr 05	2009
Buffalo Ridge Outlet	2nd qtr 06	2011
Buffalo Ridge – Metro 345	3rd qtr 06	2012
Boswell – Wilton 230	3rd qtr 06	2012
Fargo – Alexandria – Benton County 345	4th qtr 06	2012
Prairie Island – Rochester – LaCrosse 345 *	4th qtr 06	2012
Group II – Around the Twin Cities		
Forbes - Arrowhead		
Benton County – Chisago 345		
Benton County – Granite Fall 345		
Benton County – St Boni 345		
Arrowhead – Chisago 345		
Group III – Remote Generation Outlet		
Antelope Valley – Jamestown – Maple River 345		
Columbia – North LaCrosse 345		
Chisago – Prairie Island 345		
Group IV – Remote Generation Outlet		
Hettinger – Ellendale – Granite Falls 345		

- Engineering modeling, regional planning, and need analysis established the Group 1 project list.
- Total Group 1 cost will exceed $600M
- Groups 2, 3, and 4 have also been forecasted but the project list will evolve as more detailed analysis proceeds.

Source: CapX 2020, updated May 06

SW MN Transmission Planning -- Wind Power

Initial **825 MW** Wind Generation

- Study completed 2001; regulatory approval 2003
- 425 MW operational 2005; 825 MW operational in 2007

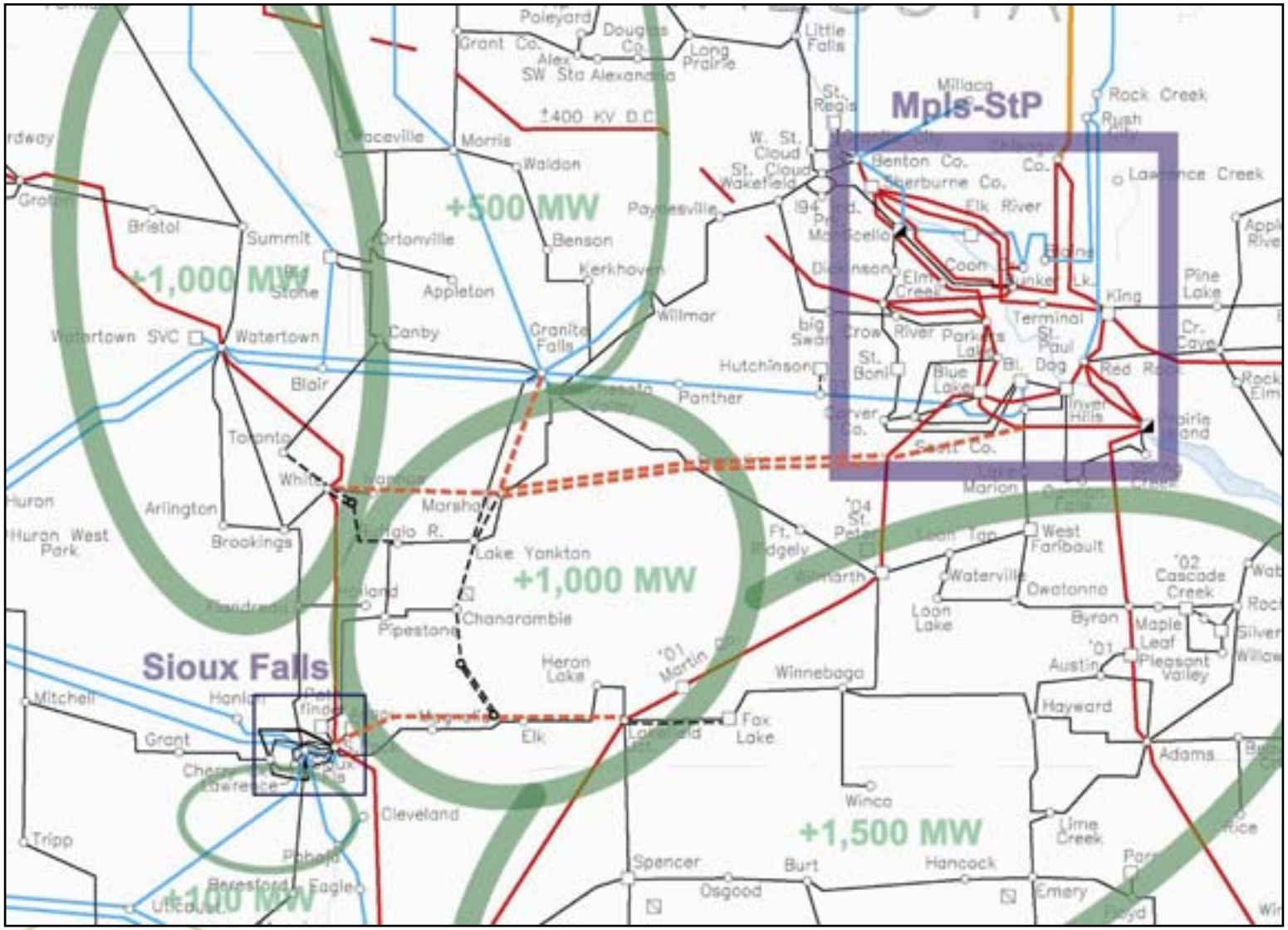
Incremental **400 MW** Wind Generation

- Investigated feasibility of an "Interim Step" transmission plan for achieving 400 MW of additional outlet capacity
- Recommended two 115 kV lines
- Regulatory process underway; Certificate of Need expected 2nd Quarter 2006

Additional **1000 MW Wind** Generation

- Evaluated & recommended a 345 kV based plan
- Certificate of Need expected 3rd Quarter 2006

SW MN Transmission Planning -- Wind Power



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Optimizing Power System Operations

MISO Ancillary Service Markets

- MISO is developing Ancillary Service Markets
  - Regulation Services
  - Contingency Reserves
- Simultaneously co-optimized with existing energy markets
- Consolidation of certain Balancing Authority functions
- Schedule
  - **April 06**: Informational FERC filing & Roundtable Discussion
  - **August/September 06**: File tariff modifications
  - **2007/2008**: Implement markets

2006 MN Wind Integration Study Objectives

- Evaluate the impacts on reliability and costs of increasing wind capacity to **20% of Minnesota retail electric *energy* sales by 2020** (perhaps 35% of installed *capacity*)
- Identify and develop options to manage the impacts
- Coordinate with recent and current regional power system study work
- Produce meaningful, broadly supported results through a technically rigorous, inclusive study process
- Study to be completed: **2006 November**

Transmission information

Wind on the Wires

http://www.windonthewires.org/